Remarks:

Claims 2-3 and 7 have been cancelled; claims 1, 4, 8, 13, 20-23 have been amended; and new claims 42-44 have been added. Reconsideration of the rejections is respectfully requested.

The claim fee status is as follows:

☒ Large Entity

		After Amdmt	Paid for	Fee due for	Fee code
	Independent Claims:	4	3	1	Lg =102 Sm =202
	Total Claims	23	41	0	Lg =103 Sm =203

The claims have been amended to more clearly define the invention. Support for the amendments is either apparent, or is as described in the text below. Support for the recitation of the crush strength in claim 4, can be found, for example, in Example 15, and in Figure 5. Support for the amendments in the recited ranges of the reducible metal oxides in claims 20-23 can be found, for example, at page 15, lines 13-14. No new matter is added.

Claim Rejection under 35 U.S.C. §102(b)/103(a) - van der Wal et al.

Claims 1-8, 10-12, 14 and 16 stand rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over van der Wal et al. In particular the Examiner asserts:

> No distinction is seen between the process disclosed by van der Wal et al., and that recited in applicant's claims 1-8, 10-12, 14 and 16. van der Wal et al. disclose a process for carrying out the water gas shift reaction in the presence of a catalyst containing mixed oxides of iron with one or more metals consisting of zinc, copper, cobalt and of metals of Groups IV-VII of the Periodic Table of the Elements, wherein the mixed oxide is on a thermal stable oxidic carrier which has a specific surface area of more than 10 square meters per gram. (See the abstract and column 4, lines 32-54. van der Wal et al. specifically disclose at column 8, lines 4-15 that the thermally stable support may be aluminum oxide having a specific surface area of more than 100 square meters per gram. Accordingly claims 1-8, 10-12, 14 and 16 appear to be anticipated by van der Wal et al. In any event, it would be prima facie obvious to employ aluminum oxide having a specific surface area of more than 10 square meters per gram as the

> catalyst support for the catalyst of van der Wal et al., since van der Wal et al. suggest at column 8, lines 4-15 that aluminum oxide having such a property should be used as a support for the catalyst disclosed at column 4, lines 32-54.

Applicants respectfully disagree. The instant invention provides a method for conducting the water-gas shift reaction that uses water-gas shift reaction catalysts that are non-pyrophoric. Use of such catalysts significantly reduce the pyrophoric hazard associated with many water-gas shift reaction catalysts that occurs upon exposure of the catalysts (in reduced oxidation states) to atmospheric air. Mere use of a high heat capacity particulate support does not assure the non-pyrophoric properties associated with use of the catalysts of the invention. Rather, the non-pyrophoric properties are also derived by the manner in which the reducible metal oxide and the catalytic agent are dispersed on the high heat capacity particulate support. The reducible metal oxide as well as the catalytic agent must be in intimate contact with the high heat capacity support to achieve efficient heat transfer from the components that have a relatively lower heat capacity, i.e., the reducible metal oxide and the catalytic agent, to the high heat capacity particulate support. Such intimate contact is achieved by impregnation of the high heat capacity support with the catalytic agent and reducible metal oxide. Absent a mechanism for achieving efficient heat transfer, exposure of water-gas shift catalysts in a reduced oxidation state to air can result in rapid and significant temperature increases.

Illustrative of this phenomena are the comparative pyrophoricity data obtained upon exposure of copper-based catalysts in Table 6 of Example 8 of the instant application. Exposure of copper-based catalysts in their reduced state to atmospheric air results in a rapid and significant temperature increase due to the heat associated with the oxidation of the copper, unless provisions are made to carry away the heat. The catalysts described in Example 8 all contain an alumina support. Commercially available copper-zinc catalysts contain alumina along with zinc oxide as a support; however, such catalysts are prepared by a co-precipitation procedure (see Twigg, Exhibit A) rather than an impregnation procedure. Upon exposure of the commercially available copper-zinc catalysts to air under the conditions described in Method B, a calculated temperature rise of over 600 °C is observed. In contrast, when catalysts of the invention (which are prepared by an impregnation procedure) are subjected to oxidation in Method B, significantly lower temperature rises (i.e., at least 5 times lower temperature rises) are observed.

Although van der Wal discloses use of oxidic carrier materials such as aluminum oxide in the catalyst what it does not teach are catalysts that have a catalyst architecture that allows efficient heat transfer from the catalytic agent or reducible metal oxide to the high heat capacity particulate support. The compositions of van der Wal et al. are prepared by precipitation of the active component onto the substrate material (see the methods described in columns 11 and 12). This technique results in a different physical relationship between the components of the catalyst including the support. This architecture is unlikely to achieve the desired reduction in pyrophoricity. Moreover, van der Wal et al. does not disclose the desirability of preparing their compositions by other dispersing techniques, nor does it disclose the desirability of preparing catalysts with reduced pyrophoricity. Accordingly, reconsideration and withdrawal of the rejection is respectfully requested.

Claims 20-22 stand rejected under 35 U.S.C. §103(a) as being unpatentable over van der Wal et al. In particular the Examiner posits:

> It would be prima facie obvious to modify the process parameters as recited in claims 20-22, since it would be within the skill of one of ordinary skill in the art to determine suitable or optimum process parameters such as the volume of carbon monoxide in the input gas stream, and the volumes of hydrogen and water. There is no evidence on record of unexpected results which would emanate from the process which includes the specific process parameters as recited in claims 20-22.

As was discussed above, van der Wal et al. neither teaches or suggests use of water-gas shift catalyst compositions having the high heat capacity particulate support materials impregnated with the reducible metal oxide and the catalytic agent. As such, Applicants submit that van der Wal et al. neither teaches nor suggests the claimed invention. Reconsideration is respectfully requested.

Claim Rejection under 35 U.S.C. §102(b)/103(a) - Sugier et al.

Claims 1-5 and 7-19 stand rejected under 35 U.S.C. § 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Sugier et al. Specifically, the Examiner asserts:

> No distinction is seen between the process disclosed by Sugier et al., and that recited in claims 1-5 and 7-19. Sugier et al. disclose a catalyst for producing hydrogen by reaction of carbon monoxide with water, wherein the catalyst contains by weight 10 to 60% of copper oxide, 5-40% zinc oxide, 1 to 20% of a rare earth metal oxide, 30-70% of aluminous cement and 0.01 to 1% of a group VIII noble metal. (See the abstract and column 1, line 19 - column 2, line 18.) The aluminous cement employed by Sugier et al. is considered to constitute a "solid high heat capacity particulate support" as recited in applicant's claims. Regarding claims 8 and 9, Sugier et al. specifically disclose cerium oxide as one of the rare earth metal oxides at column 1, lines 33-36.

Applicant respectfully disagrees. Applicants' method is conducted using a non-pyrophoric water-gas shift reaction catalyst. As described above, such non-pyrophoric catalysts are prepared by impregnation of the high heat capacity particulate support so as to achieve the desired intimate contact of the support with both the catalytic agent and reducible metal oxide. The intimate contact of the support with these components ensures efficient heat transfer to the high heat capacity particulate support.

Applicant's submit that catalysts disclosed in Sugier et al. are not prepared by an impregnation of the copper component or reducible metal oxide on to the aluminous cement. For instance, in the preparation entitled, "Catalyst B" zinc carbonate, copper carbonate, and lanthanum carbonate are first combined with the aluminous cement, and then the cement is set with an aqueous solution of ammonium carbonate to form balls. The balls are then matured and heated at 400 °C in air. An analogous procedure is described for a compositions wherein cerium carbonate is used in place of lanthanum carbonate in "Catalyst C". Such procedures result in catalysts that have the copper, ceria and alumina in a physical mixture, and are unlikely to form catalysts having the same intimate contact of the copper and cerium on the aluminum support as in Applicants' invention. The mixture of catalyst components in Sugier et al. is unlikely to provide the catalysts with the copper and ceria disposed directly on the alumina support which could function as a heat sink.

Accordingly, the methods using the catalysts disclosed in Sugier et al. does not disclose or suggest Applicants' method. Reconsideration and withdrawal of the rejection is respectfully requested.

Claim Rejection under 35 U.S.C. §102(b)/103(a) - Tang et al.

Claims 1-5 and 7-19 are rejected under 35 U.S.C. §102(a) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Tang et al. The Examiner asserts:

> No distinction is seen between the process disclosed by Tang et al., and that recited in claims 1-5 and 7-19. Tang et al. disclose a catalyst suitable for the conversion of carbon monoxide with steam into carbon dioxide and hydrogen, and a process for such conversion, wherein the catalyst comprises cobalt oxide or nickel oxide as the active component, a carrier having titanium dioxide along with aluminum oxide, and a promoter which may be a rare earth element or copper. (See the abstract and column 2, lines 24-67). The carrier comprising titanium dioxide and aluminum oxide is considered to constitute a "solid high heat capacity particulate support", as recited in applicant's claims. Regarding claims 8 and 9, Tang et al., specifically disclose cerium oxides as one of the rare earth metal oxides at column 3, lines 3-42.

Without conceding the correctness of the rejection, claims 1-5 and 7-19 have been amended to more particularly and distinctly define the subject of their invention. In particular, Applicant notes that the claims are distinct from the cobalt- or nickel-based catalyst compositions of Tang et al. Reconsideration of the rejection is respectfully requested.

Claim Rejection under 35 U.S.C. §102(b)/103(a) - Lywood et al.

Claims 1-5, 10, 17 and 18 stand rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Lywood et al. Specifically, the Examiner asserts:

> Lywood et al., disclose a process for carrying out the water gas shift reaction in the presence of a catalyst comprising platinum and/or palladium on a refractory support, which may be impregnated with an alkali, or alkaline earth, metal compound before or after incorporation of the palladium or platinum and heated to convert the alkali, or alkaline earth, metal compound to the oxide formed. (See the Abstract and column 4, lines 20-68.) Lywood et al. suggest at column 3, lines 56-60 that the refractory support may constitute alumina. The refractory support, such as alumina disclosed by Lywood et al. is considered to constitute a "solid high heat capacity support", as recited in applicant's claims. Moreover, the alkali or alkaline earth metal oxide disclosed at column 4, lines 57-58 of Lywood et al., is considered to constitute a "reducible metal oxide" as recited in applicant's claims.

Applicants respectfully disagree. For a claim to be anticipated each and every element must be found, either explicitly or inherently described, in the reference. See MPEP 2131. As recited in amended claim 1, an alkali or alkaline earth metal oxide is not considered to constitute a reducible metal oxide. Accordingly, Applicants submit that Lywood et al. does not teach or suggest a reducible metal oxide as recited in Applicants' claims. Reconsideration is respectfully requested.

Claim Rejections under 35 U.S.C. §112, second paragraph

Claims 1-23 stand rejected under 35 U.S.C. §112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In particular, the Examiner alleges that the terms "high heat capacity particulate support" or a "high strength support" is indefinite, since the word "high" is a relative term with no definite boundaries.

Applicants note that the term "high heat capacity support" is specifically defined in the specification at, for example, page 12, lines 1-3. Moreover, Applicants have amended claim 1 to more particularly define the invention with respect to the high heat capacity particulate support. Accordingly, Applicants submit that the term is definite.

Properties of high strength support are specifically exemplified in the specification in the working examples 15 and 16, and in Figure 5. Moreover, claim 4 has been amended to more particularly define Applicants invention.

The Examiner rejected claims 20-23 as indefinite, since these claims recite "up to" in describing the amounts of the oxides or cerium or chromium in the catalyst.

Without conceding the correctness of the rejection, Applicants have amended claims 20-23 to more particular define the range of reducible metal oxide in the catalyst compositions.

Accordingly in light of the above discussion, reconsideration of the rejections under 35 U.S.C. §112 is respectfully requested.

Closing Remarks

Applicants thank the Examiner for the Office Action and believe this response to be a full and complete response to such Office Action. Accordingly, favorable reconsideration in view of this response and allowance of the pending claims are earnestly solicited.

FEE DEFICIENCY

☒ If an extension of time is deemed required for consideration of this paper, please consider this paper to comprise a petition for such an extension of time; The Commissioner is hereby authorized to charge the fee for any such extension to Deposit Account No. 04-0480.

and/or

☒ If any additional fee is required for consideration of this paper, please charge Account No. 04-0480.

Respectfully submitted,

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